Understanding Systems Thinking: An Agenda for Applied Research in Industry

Pamela Buckle Henning
Jacqui Wilmshurst
Mike Yearworth

Abstract

Why systems thinking is valuable is relatively easy to explain. However, in the authors' work as university educators, teaching a student processes of enquiry that are themselves systemic is a difficult undertaking. The capacity to view the world in systemic ways seems an innate characteristic that some individuals possess. Might it be the case that being a systems thinker is dependent on holding a particular worldview? Systems theorists have evolved tools and methodologies to help people do systems thinking. Is being a user of systems methods the same as being a systems thinker? Are certain cognitive competencies, styles, or preferences required for people to make effective use of such tools and methodologies?

Systems thinking, then, is a much-discussed, little understood human process. People value systems thinking for various reasons. To certain individuals, it is quite simply the thinking strategy best suited to the complex problems of a 21st-century world. Others view it as an ethical imperative, given the interdependence characterizing life on this planet. For some, the term 'systems thinker' signifies their sense of belongingness to a community of like-minded thinkers, and for yet others it may be an unavoidable consequence of the way that their brains process new information and make sense of the stimuli presented by the world. How do these different takes on what systems thinking means shape how it is developed in individuals and taught to students in higher education?

These are among the queries that can arise for those interested in developing systems thinking abilities in themselves and others. Such queries have catalyzed a research agenda for the authors – who bring widely varying perspectives from their work in information technology, psychology, engineering, and management – to the question: What exactly is systems thinking?

Introduction

Systems Thinking has developed a substantial following the past few decades. As it has been used and adapted as an approach, it has diversified in the different contexts in which it has evolved. Discussions as to the nature and value of systems thinking take place in many forums and across myriad sectors and disciplines, and for this reason it would be beyond the scope of this paper to capture adequately the range of perspectives across the full spectrum. Instead, the intention here is to focus on those areas that are within the personal experience of the authors, who come from backgrounds in business and management, psychology, and engineering management respectively. Clearly this means that the material discussed here can only be a fraction of that which is available, but it is our hope that by presenting our own experiences, perspectives, questions and ideas we can

stimulate new discussion, debate and research initiatives that can help to shed light on what exactly we mean when we say we are 'systems thinkers'.

Alongside the scope of the material that we bring for discussion, it is important also to declare at the outset what are our intended goals for this paper, so that the outcomes can most effectively be directed at tangible progress towards understanding and applying systems thinking and do not end up limited to interesting and intellectually stimulating, but ultimately unusable conclusions. Again here we turn to the interests and expertise of the authors, all of whom have a particular interest in the application of systems thinking in higher education and in business and industry, in order to promote and enable more effective solutions to complex problems. Our interests are specifically in understanding exactly what it means to 'do systems thinking' or to 'be a systems thinker' in these contexts, and then as a next step to develop ways in which we can effectively select individuals who possess the appropriate preferences, aptitudes, and competencies for systems thinking and design ways to facilitate and enable their development.

In order to take a first step towards these goals, we aim to present in this paper a number of suggestions as to the current scope of what people mean by 'systems thinking' in the contexts in which we work. We then offer a selection of existing theories and bodies of work with which we are already familiar and that we think may offer a useful start in exploring these styles, preferences, competencies and skills further. We do this by breaking down the broad spectrum of different perspectives on systems thinking that we have encountered in our work into a number of themes, exploring each theme in more detail, and introducing the work that we believe may be the most relevant and helpful in tackling some of our initial questions. We finish by presenting a number of research questions that we invite others to discuss and pursue so that collectively we can address this fascinating and so far little-addressed avenue of research.

The Concept of Systems Thinking

Reductionist reasoning has an esteemed tradition of generating greater understanding of the world in which we live. In many contexts, it is a productive way of investigating problems and generating effective solutions. However, it is well known that there are problems whose solutions have eluded those who utilize a reductionist paradigm.

Many writers have discussed the importance of bringing about more integrated ways of seeing the world. Capra has introduced to a wide public the idea of the living world as an interconnected web (1996), an idea he has extended to emphasize the hiddenness of many of the connections that bind living systems (2002). Laszlo, too, has written of the crucial importance to having a holistic vision of whatever mode of inquiry in which we are engaged (1996), that we must grasp the integral coherence of a world that, we must admit, often behaves in surprising ways (2006). These writers and others draw attention to the interconnectedness of things. In contrast to the mode of thought espoused by reductionism, they urge us to see beyond the objects and components within the systems that surround us; urging us, rather, to examine the connections and relationships between them in order to gain a deeper understanding of how things work. Further, they argue that such a mode of investigation has widespread applicability, illustrated by their explorations of living

systems on earth, sustainable living, the human mind, consciousness, and the cosmos. While reductionism has shown us much about nature, the universe, and ourselves, systems thinking can show us more, whether this way of thinking that complements reductionism is referred to as holistic thinking, having an integral view, or otherwise.

Understanding interconnectedness has value in each of the authors' areas of interest. Management is the study of how individuals come together to accomplish tasks too large or complex to be accomplished alone. In business and management language, systems thinking involves uncovering an understanding of the patterned ways in which the information (Gharajedaghi, 2005), values (Checkland, 1999), and ideas that individuals possess interact in ways that produce particular workplace behaviours and events. For many who work in business environments, systems thinking is a matter of focusing one's attention on the system-wide structure that results from the causal connections that have developed among sometimes considerably disparate groups of people (Jackson, 2003; Senge, 1990; Sterman, 2000). Psychology is a wide-ranging study of the mind. This discipline is often assumed to focus solely on the mind of the individual, and its founding fathers did indeed make impressive discoveries about the intrapsychic workings of human nature. However, psychologists recognize that even a meticulous understanding of the psyche and behaviour of people is limited in its ability to explain how individuals operate in the context of the human systems in which they live and work. Understanding the psychology of the individual lacks in its ability to help us know how a group of people will function together, or indeed how to work with problems that arise through difficulties in the relationships between its members. Several approaches to psychology have emerged from scientists and clinicians recognizing the limitations of focusing exclusively on the individual: transactional analysis of the relationship patters in which a person finds him/herself (Berne, 1996); psychosynthesis, which draws on both scientific and religious ideas in its aim to create a harmonious integration within and between the personal and transpersonal domains of human existence (Hardy, 1996); and approaches that challenge the assumption that a person's very identity is in any way personal (rather, that every identity is a product of shared consciousness in which people participate together) (e.g. DeQuincey, 2005). These psychological approaches and others seek to understand the individual-in-context. Engineering is the application of knowledge and principles from across the sciences to the design and development of artifacts, machines, structures, and so on with practical use in the world. As a discipline it encompasses consideration of all aspects of operation of its artifacts with regard to, amongst others, safety and ethics and economics. However, the boundary between the outputs of engineering, across *all* the engineering disciplines, and the social world, and the essential trade-offs between constraints, is what makes engineering quite distinct from a pure science. It is in this space of the socio-technical that the most significant challenges for engineering and engineers are to be faced. What systems thinking (by that name or otherwise) in engineering looks like is not a clear picture. Systems Engineering (INCOSE 2009; Hitchins 2007) encompasses notions of systems in terms of understanding and translating into reality requirements for complicated artifacts but is essentially tool and process-based and apparently does not *depend* on systems thinking or systems thinkers according to the questions we are exploring in this paper. The work of Checkland and Forrester, both originally engineers by discipline, embody career trajectories into what systems thinking has meant for them. The

term *Engineering Systems* is perhaps a better articulation of what systems thinking in engineering could become and here we quote from MIT's Engineering Systems Division (ESD), which aims to

> *"…solve complex engineering systems problems by integrating approaches based on engineering, management, and social sciences—using new framing and modeling methodologies. ESD seeks to facilitate the beneficial application of engineering systems principles and properties by expanding the set of problems addressed by engineers, and to position its graduates as leaders in tackling society's challenges"*[1]

- which echoes the intention behind the UK's Royal Academy of Engineering report into "Creating Systems That Work" (RAEng 2007). However, what exactly these principles are, and the skills needed to be the leaders talked about, are a subject for debate and reflection (Yearworth et al, 2011; Yearworth, 2011) and distinct clarity (Blockley, 2010).

Systems thinking - by that name or any other - has attracted the attention of people working within each of the disciplines in which the authors work.

The ability to perceive the systemic structures inherent in business, psychology, and engineering has value in addressing the pressing problems faced by each of these disciplines. Given that reductionism has dominated problem solving approaches, and indeed even the current paradigm since the Age of Enlightenment, it is not surprising that those who do see the world in integrated, holistic, and systemic ways may have built up a fair amount of frustration at not having their way of perceiving and working with the world valued. This can lead to a tendency for a 'pendulum swing' towards a paradigm that is in competition with the current one. We do not wish to propose that systems thinking ought to replace reductionistic reasoning, only that we need to take a closer look at the nature of systems thinking itself. In part, we suspect, systems thinking has not received as widespread acceptance as reductionism because it is a way of thinking that is not well understood.

Systems thinking is a widely-used phrase (Buckle Henning & Chen 2011). In conversations we have observed in our workplaces and at ISSS meetings, it is generally assumed that everyone means the same thing by this term. As educators interested in teaching systems thinking to others, we have found ourselves wondering what are the requirements of a systems thinker? Is 'being a systems thinker' depending on holding a particular worldview? On having certain cognitive competencies? Certain personality preferences? At present, we do not understand what kinds of thinking are going on when a person *does systems thinking*. If we better understood systems thinking's constituent parts – worldviews, competencies, preferences, or otherwise – we could develop a rigorous systems pedagogy for the students we teach, and for the managers and clinicians to which we consult. We could better understand the differences between those skilled at reductionist reasoning and systems-thinking-problem-solvers, and could assist industry in selecting the best people for both. We could help to enable and develop the relevant abilities for whichever paradigm best suits the particular challenges of a workplace at any

[1] http://esd.mit.edu/

particular point in time. We could, we feel, strengthen systems thinking's ability to create real-world impact on pressing problems.

A Proposition

In order to bring about a clearer understanding of what ST means to the growing community of academics and practitioners who use the term, it is useful to give language and structure to the term in order to provide material for discussion. Given conversations we have had together, and our experiences teaching and researching systems thinking as an approach to handling complexity, we propose that systems thinking is a multi-layered phenomenon. We offer a provisional structure to the phenomenon here that we hope serves as an invitation to further discussion.

In our respective studies and practice, we have come across ST used and discussed in a number of ways. These have broadly fallen into the following themes:

1. **The deliberate use of particular vocabulary, tools, and problem solving techniques (i.e. systems thinking as methodology)**
2. **Cognitive styles and competencies**
3. **Worldview (i.e. systems thinking as ontology)**
4. **Ethical imperative (i.e. systems thinking as morality)**
5. **Identity (i.e. systems thinking as community)**

We explore each of these themes here, introducing them as potentially-fruitful areas of enquiry in order to better understand what is systems thinking. Further, we present a number of research questions that arise from each theme.

1. Systems Thinking as the Use of Particular Tools and Methods

Within this theme we see systems thinking expressed as problem-structuring and problem-solving approaches arising from the challenge of dealing with complexity and operating within a problem/opportunity space defined by industrial, academic, and/or societal stakeholders. Dealing with emergence and designing for synergy are key challenges in this context. Systems thinking is thus defined as a tool, process, and/or model-based approach and that generally assumes that if one is using these tools and techniques then one is 'doing systems thinking' or 'being a systems thinker'. The tools, methods, methodologies and processes are myriad, and their selection and use in an engineering context characterized by either i) framing devices such as Jackson's System of Systems methodologies (SoSM) or Minger's characterization of philosophical assumptions (Mingers, 2003; Jackson, 2003; Jackson, 2000), ii) heuristic-based systems practices (Blockley & Godfrey, 2000), or iii) model and simulation based approaches (Chaturvedi, 2009; Pidd, 2004). This take on systems thinking, whilst prevalent in the context of engineering, clearly overlaps with thinking in Management Science/OR.

Several research questions arise from the view that systems thinking involves the deliberate use of particular vocabulary, tools, and problem solving techniques. What enables someone to perceive a system to which systems methods and tools can be applied? (Or, does applying systems tools make something a system?!) What cognitive processes are involved in being able to use systems tools, or make *effective* use of them? Is systems

thinking *merely* the selection of appropriate tools and techniques according to determination of problem context? Merely I "right tool for the job" thinking?

One view we have detected in conversations about systems thinking is that a person is a systems thinker if they use systems thinking tools. However, other possibilities exist. For example, if we take away the use of tools, what might it mean to be a systems thinker then?

2. Systems Thinking as a Set of Cognitive Styles and Competencies

Here we introduce the idea that those who find their way into systems thinking, or indeed to a more holistic and integrated way of approaching situations and problems, may do so because of a set of cognitive styles, competencies, and/or preferences that they possess. Whether our psychological styles and preferences have come about through genetic (i.e. are innate in some way) or environmental factors (such as parental training, formal education) is an argument that pervades psychology and beyond, and is certainly beyond the scope of the current discussion, but what is of relevance here is that we all possess such styles, competencies and preferences. The question we ask here is whether a certain set of these may predispose an individual either to find their way to systems thinking, for example due to a feeling of ill fit with reductionist methods and training to which they have been exposed in their formal education, or to adapt quickly and effectively to this approach and its accompanying philosophy, tools, methods.

In order to explore this question, there are a number of possible strategies to adopt. Certainly taking a grounded theory approach to conduct in-depth conversations with self-defined systems thinkers would be of great value in order to begin to develop a theory of 'the systems thinker' and to begin to build a profile of traits, competencies, styles and preferences. Alongside such an approach, there are also a great number of existing bodies of knowledge that may be of great use in their application to this question. A thorough overview of such bodies of work would too great an undertaking here, so instead what is offered is a brief introduction to a few fields of research that may be of use in designing new research into the nature of systems thinking and of the systems thinker.

One example of an area of potential overlap is with leadership. Many conversations about the competencies and skills of effective systems thinking lead to the identification of skills that may just as easily be involved in a discussion about leadership. Examples might include the ability to put a problem into context and to 'see the bigger picture', to see the interconnections between different aspects of a situation or problem, to be creative in finding new and innovative solutions to problems, and to involve all stakeholders in the problem analysis. Clearly there are also many aspects of leadership that do not necessarily have so much to do with systems thinking, such as influencing others and creating behavioural change, although depending on the context these could also be included.

Another area that seems ripe for exploration is that of a systemic style of thinking and approaching problems with some already very well personality assessments such as the Myers Briggs Type Indicator (Myers et al, 1985) and the Singer-Loomis Type Deployment Inventory (Singer et al, 1996). Such tools uncover a preference for certain personality styles over others, such as an intuitive style versus a sensing one, or an emphasis on feeling

rather than thinking that may prove to have some correlation with preferences towards systems rather than reductionist thinking. If such correlations do indeed emerge, such tools could be enormously helpful in identifying and developing those with the existing styles and competencies of a systems thinker in order that they may be further refined.

Also on the subject of thinking styles, the field of cognitive psychology has much to offer in terms of understanding differences that may map onto systems thinking in some way. For example, convergent and divergent thinking styles and preferences may lend themselves to reductionist and systemic approaches respectively, as might differences in tendency towards global or local processing of information. For an overview of cognitive styles, see Riding & Cheema, 1991.

Spanning the fields of cognitive psychology and cognitive neuroscience, there is increasing evidence as to the role of different regions of the brain in determining how we approach problem solving and make sense of our world. There are fascinating studies that shed light on differences in gender, academic subject matter preferences (eg. sciences and mathematics versus arts and humanities [Baron-Cohen et al, 2001]) and even certain 'disorders' such as dyslexia (Everatt et al, 1999) and autism (Reed et al, 2011). Many of these studies suggest differences in how we process information in terms of the level (eg. 'local' or 'global') and the degree to which we process different aspects of a situation in isolation or as an interconnected entity.

The many fascinating areas of existing research that may help us to build a more complete and multi-faceted picture of what is happening when someone chooses systems thinking. Research questions that can delve more deeply into the potential provided by cognitive psychology and cognitive neuroscience are many. Is systems thinking an essential leadership competency? Are effective leaders good systems thinkers? Is there a relationship between personality type (particularly the intuitive function) and the capacity for systems thinking, or are other type modes equally as amenable to systems thinking? Is systems thinking related to global information processing levels in the brain? Is there a negative correlation between the competencies associated with systems thinking and autism quotient scores? Particular cognitive styles, competencies, and/or preferences may be important factors in systems thinking. So too might particular worldviews.

3. Systems Thinking as Worldview

"A comprehensive world view (or worldview) is the fundamental cognitive orientation of an individual or society encompassing the entirety of the individual or society's knowledge and point-of-view, including natural philosophy; fundamental, existential, and normative postulates; or themes, values, emotions, and ethics." (Palmer, 1996). The term comes from the German world 'Weltanschauung', which translates literally as 'welt': 'world' and 'anschauung' as 'view' or 'outlook'.

The term 'worldview' is increasingly being used to refer to the general lens through which the world is seen by an individual, a group, or even a whole society. At the level of the individual, with whom we are most concerned here, it could be described as the collection of perceptions, attitudes and beliefs that an individual holds in relation to the world around

him/her; this then shapes the way this individual responds to stimuli and situations presented by the environment. This will include relationships, problems to be solved and even which theories that person is most likely to select to apply to a question or problem that he/she faces.

So what is the relevance of the concept of 'worldview' to the current discussion? For us, it informs the questions that we are asking as to the nature of systems thinking and of the 'systems thinker'. On the one hand, it is possible that by employing certain tools and methods that have been devised and named as part of a 'systems approach', as discussed earlier, one could describe oneself as a 'systems thinker' or, as 'doing systems thinking'. Or, one might feel that being a 'systems thinker' is more about a set of competencies, for example of being able to 'see' patterns, connections and relationships between the components of a system in such a way that the system as a whole becomes more easy to understand and intervene in. The suggestion here is that whilst both of these possibilities are perfectly realistic and indeed are not mutually exclusive, it is also possible that without a worldview that is compatible with seeing the world around us in interconnected wholes and networks of relationships, it is not possible even with the best available tools and the required cognitive competencies, to work effectively with whole systems. Or, it may be that it is perfectly possible, but that without a 'systems worldview' it is simply not likely that an individual will choose to approach the world and the problems that it presents to us in that way. The work of Ervin Laszlo illustrates this thought well.

He says: "The systems method always treats systems as integrated wholes of their subsidiary components and never as a mechanistic aggregate of parts in isolable causal relations" (1996: p.10). He goes on to give examples of contrasting worldviews in different contexts to illustrate some of the ways in which holding a 'systems view of the world' may bring about changes in the way that one interacts with the world. For example:

- *"The classical worldview was atomistic and individualistic: It viewed objects as separate from their environments and people as separate from each other and from their surroundings. The systems view perceives connections and communications between people and nature, and emphasizes community and integrity on both the natural and the human world."*
- *"The classical worldview was materialistic, viewing all things as distinct and measurable material entities. The systems view gives a new meaning to the notion of matter, of energies that flow and interact, and allows for probabilistic processes, for self-creativity, as well as for unpredictability.*
- *The classical worldview was also anthropocentric, perceiving human beings as mastering and controlling nature for their own ends. The systems view sees humans as organic parts within a self-maintaining and self-evolving whole that is the context and the precondition of life on this planet."*

For the current discussion, what this brings is the idea that perhaps choosing 'systems thinking' can, at least in some cases, be more likely to have been as a result of holding a worldview such as those systems views described above, in contrast to the more traditional reductionist approaches in which most of us are trained and immersed throughout our

formal education. This is not to say that following the realization that one sees the world in this way and finds that a systems approach fits with their perceptions, attitudes and beliefs about the world, an individual will not still then look for the appropriate tools and methods with which to approach a question or problem (which may include classical reductionist tools and methods). We have observed tensions between people who view systems thinking as the deliberate use of systems tools and those viewing it as the natural outcome of holding a particular worldview. Arguments about which is right are fascinating for some and a strain for others. A third option is possible – that both have merit in the fields of management, psychology, and engineering, representing worthwhile facets of the nature of systems thinking.

Research questions arising from the possible relationship between tools and methods, competencies and styles, and worldview are many. Is being a systems thinker dependent on holding a systemic worldview? If one does not hold a worldview that is compatible with a systems approach and therefore the use of 'systems thinking' tools, are those tools still going to make sense to that person and be seen as valid, useful and appropriate against those on offer which are more compatible with a reductionist approach? Is there any merit to attempting to instill systemic worldviews in people whose worldviews are reductionistic? This question is an extremely important one for those who are keen to educate others in systems approaches, as the assumption that this is the way that the world is and that therefore systems tools and methods are superior to others could result in significant barriers in communication between teacher and student. Similarly, if it is found that some people have cognitive styles and competencies (as discussed in section 2) that appear to be more compatible with using a systems approach, or 'doing systems thinking', or 'being a systems thinker', then are these people more likely to hold a systems worldview as a result of living with these styles and competencies? Are their cognitive strategies that correspond with systems thinking worldviews? Does having a systemic worldview enable one to access or utilize certain cognitive skills? Is it contingent on having particular personality preferences? If an individual has both a systems worldview and styles, competencies, or preferences that most lend themselves to a systems approach, will they be better at learning about and understanding systems tools and methods? For someone to 'be a systems thinker' do they need to hold the worldview, have the relevant styles and competencies *and* use the tools and methods, or do any one or two of these ingredients suffice? Are there differences between those who have found their way into the world of systems because they inherently have a worldview compatible with that world (e.g. people who 'are systems thinkers') and those who have been trained to be systems thinkers through university training programs or consulting interventions (e.g. people who 'do systems thinking')?

To our observations that systems thinking involves the use of tools for some, and the possession of systemic worldviews for others, we have detected a third theme: ethics.

4. Systems Thinking as Ethical Imperative

Insofar as all of us live within systems, rely upon them, and interact with them for our survival and pleasure, any decision or action we take for our own good will impact others – for others, too, share the systems in which we live, on which we rely, with which we

interact. The impacts we have on one another – for good or ill – bring considerations of responsibility into systems thinking. As the realm of systems is one of profound relatedness, so to is the realm of ethics. What is the morally responsible role of purposive human activity in the natural, economic, cultural, etc. worlds – worlds we understand to be deeply interconnected, deeply systemic? Systems thinking is inherently about a widened view of what and who matters – and in human systems, how parties ought to be treated.

Those systems thinkers who ponder such issues ascribe value to the systemic nature of nature, organizations, or whatever their domain of inquiry. To Jung (1971), the human capacity to make value judgments and prioritize resides in the feeling function of the personality. Are there affective experiences that systems thinkers encounter when judging what elements, interactions, processes, or outcomes of a system should be considered important, significant, worthwhile? Are particular qualities of care and concern common among systems thinkers, regardless of whether their domains of interest are, for example, chronic poverty in developing nations, military defense, bioscience, or urban development?

While systems domains of interest are myriad, many people come to systems thinking because they have been charged with the particular responsibility to design effective systems – mechanical systems, computerized systems, educational systems, health systems, monetary systems… A key question facing such people is, of course, how ought these systems be designed? The matter of "ought" is an ethical one, ethics being the domain of moral principles (of right and wrong) that inform human decisions and behaviour (Audi 1995). Churchman first raised the point that systems designers should not be the only parties to decide which stakeholders' needs will be considered (Jackson 2003). The call to 'emancipate' (i.e. to include) those previously unvoiced by systems designers has been led by Ulrich (e.g. 1983). His call to improve fairness in organizational decision-making is unequivocal, as is his view that ethics are often lacking in systems design – instead of present practice, he says, managers should begin to use systems thinking "as if people mattered" (1998).

Valuing people is clearly a virtue to Ulrich. Other writers also relate the ethical dimension of systems thinking to virtuous behaviour. Pulkkinen (2007) has modeled cooperation as one form of 'systems intelligent behaviour'. Human virtues such as forgiveness, hopefulness, and dignity in the face of totalitarian regimes have been attributed to systemic ways of perceiving and reacting to such regimes (Seppä, 2007). A lack of human virtue has been suggested by Rantanen (2007) as the crucial systemic dynamic leading to the collapse of the Enron Corporation. There is no reason to assume that systems thinking is always good – no doubt ethically questionable outcomes can arise from the use of systems knowledge, methods, or tools.

Research questions arise from the confluence of systems thinking and ethics. When people engage in systems thinking as they design organizational change, lead political revolutions, or conspire in corporate wrongdoing, what interplay of cognition and affect occurs in the striving for rationality and virtue?

We offer a final theme to the present discussion that, like ethics, highlights the social nature of systems thinking: personal identity

5. Systems Thinking as an Identity Descriptor

Describing oneself as "a systems thinker" is, for some, a statement of belongingness to a community of systems thinkers. We have noticed the term used this way when people reference their membership in the International Society for the Systems Sciences, the UK Systems Society, and The Systems Centre at the University of Bristol, for instance. Used in this way, we are reminded that systems thinkers exist within a social context, having in common some form of shared understanding and experience, which Nonaka (1994) has noted is crucial for the creation of shared knowledge. The statement "I am a systems thinker" signals that systems thinking has "cognitive legitimacy" (Aldrich & Fiol 1994) among some substantial number of other people who share a paradigm about this particular way of thinking, that a consensus that has been reached with others about what systems thinking means.

But what this particular way of thinking is, we maintain, is an open question. As we have said, a wide array of meanings has been ascribed to systems thinking. Midgley has described the huge variety of ideas generated by the systems movement as one of its distinctive strengths (2000). However, if "I am a systems thinker" is meant to signal something, the potential for signaling problems becomes great when we acknowledge that systems thinking could refer to any number of consensuses, not just one. Furthermore, if, perhaps, systems thinkers exist on a scale from those cognizant of the systems thinking they do to those whose systems thinking is tacit or latent, people might belong to the fellowship of systems thinkers to various degrees – rather than belongingness being a matter of 'yes you do' or 'no you do not'.

Regardless of which form of systems thinking one espouses, or how aware one is of the systems thinking one does, being a systems thinker is an identity for some people – a way of understanding themselves as similar to other systems thinkers. Systems thinking is powerful, then, as a bonding mechanism. This view of systems thinking draws on psychological understandings of belongingness as a basic human need. It also highlights that particularly important in any community are resources that bind members together into a unified social entity. For people who see themselves as bound together with other systems thinkers, such resources include systems ideas and vocabulary, such as "systems dynamics" (Forrester 1971), "systems archetypes" (popularized by Senge [1990]), etc. Such terms contribute to systems thinkers' collective identity, to their sense legitimacy to outsiders and common understanding amongst themselves. Far more than a descriptive phrase, "systems thinker", we suspect, conveys an identity shared among people with tools, worldviews, and ethical priorities in common.

Research questions arising from our observations that, to some, "systems thinker" signifies their sense of belonging to a systems community include these: To which kind of systems thinking are people referring when invoking that term to describe themselves (a community of tool-users? Worldview-holders? Espousers of a particular ethical stance?) To which systems thinking consensus, which paradigm, are systems-thinking-people

claiming allegiance? Are systems thinkers who focus on engineering problems thinking differently than systems thinkers working to address the mental health of a family in crisis and different still from executives working to position their corporations in fast-changing industries?

Discussion

We have put forth five themes – systems thinking as the use of tools, the use of cognitive competencies, the possession of worldview, the holding of particular ethics, and the sense of belongingness. Certainly other themes are likely to be uncovered as the authors continue to ponder and begin to research the nature of systems thinking. However, we offer these five as a set of initial themes for discussion. Within them we acknowledge methodological, tool-based perspectives on the nature of systems thinking. We address ontological views that, for some, systems are the nature of reality itself, and their corresponding epistemology understands reality in ways that that are distinctly different than those with reductionist worldviews. It seems to us that a particular ethic permeates most discussions of systems thinking that we have witnessed – a conviction that, in all (we prefer many) circumstances, there is a 'rightness' to systems thinking that makes it a compelling phenomenon of study. To some people, systems thinking involves their very sense of who they are.

We have argued that systems thinking is a multidimensional phenomenon and have put forth several themes that seem important to better understanding it. In our interest for the topic, we do not wish to convey that systems thinking ought to overturn reductionist ways of addressing the problems faced by managers, psychologists, or engineers. In their enthusiasm to be heard and understood, some advocates of systems thinking can end up competing with reductionist approaches, or even rubbishing them altogether, rather than striving for an integration that leads to a more complete arsenal of approaches to solving complex problems in industry. We feel that striving for such integration is a worthwhile goal – a systems approach to overcoming the limitations of an exclusively reductionist paradigm. And we feel that, if it to take its rightful place alongside reductionistic thinking, systems thinking must be better understood.

Concluding Thoughts

We share with neuroscientists the conviction that there is currently much unfulfilled potential of the human mind. Finding ways to expand the mind's capacity seems important, given the wicked challenges of the world in which we live; it seems reasonable to believe that we can deal better with problems of complexity by expanding the human capacity to see things systemically. In systems thinking we see a challenging field of endeavour that stretches the limits of our human capacity to grasp complexity.

Many people find systems thinking intellectually satisfying – related, as it is, to sound systems science. It is psychologically satisfying in its connection to an ecologically-accurate understanding of how the material and social world is organized. It is sobering, given the moral imperative many feel to think this way. And systems thinking is frustrating, given how difficult it is to explain to others. In some way, we suspect that cognitive dimensions

are involved in systems thinking; however we do not yet know what levels of cognitive or developmental maturity are required for people to do it. Ethical dimensions are involved; but we to not yet understand what levels of moral development are required. It seems likely that social dimensions are involved; yet we cannot yet discern the emotional or interpersonal competencies it might demand. Systems thinking seems to be for some a deliberate problem solving approach and at times an unchosen reasoning style. We do not know if systems thinking is innate or learned; perhaps what is an obvious way of operating for some people cannot be urged for all people. If it is the case that some people are naturally predisposed to break down a system into its constituent parts whilst others are equally prone to see connections and wholes, then surely we should be finding ways to help people identify which is their preferred approach and in what contexts their skills and strengths would be best applied. Systems thinking, it seems, is a way of perceiving and a way of manipulating that which is perceived. A rigorous assessment of all these matters has yet to be taken.

In Russ Ackoff's 2010 book, *Systems Thinking for Curious Managers*, a member of the UK Cabinet Office: Prime Minister's Strategy Unit has written

> *Systems thinking is both a mindset and set of tools for identifying and mapping the inter-related nature and complexity of real world situations. It encourages explicit recognition of causes and effects, drivers and impacts, and… helps anticipate the effect a policy intervention is likely to have.*

As individuals with interests in seeing the fruits of our research labours applied to real-world challenges, we are heartened by this recognition from industry of the value of systems thinking. Our aim in presenting this paper at the ISSS meeting in San Jose has been to generate discussion among those who share our interest in facilitating the development of systemic thinking among those charged with meeting the challenges of industry.

References

Ackoff, R. (2010). *Systems Thinking for Curious Managers: With 40 New Management f-Laws*., Triarchy Press Ltd, Devin UK.

Aldrich, H., and Fiol, M. (1994). Fools rush in? The institutional context of industry creation, *Academy of Management Review*., 19:4:645-670.

Audi, R. (ed.) (1995). *The Cambridge Dictionary of Philosophy*., Cambridge University Press, Cambridge UK.

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001) The Autism-Spectrum Quotient (AQ): Evidence from Asperger Syndrome/High-Functioning Autism, Males and Females, Scientists and Mathematicians, *Journal of Autism and Developmental Disorders*., 31(1):5-17.

Berne, E. (1996). Games People Play: *The Basic Handbook of Transactional Analysis*., Balantine Books, New York.

Blockley, D. and Godfrey, P. S. (2000). *Doing it Differently: Systems for Rethinking Construction.*, Thomas Telford, London.

Blockley, D. I. (2010). The Importance of Being Process, *Civil Engineering and Environmental Systems*., 27(3), pp. 189-199.

Buckle Henning, P and Chen, W-C. (2011). Systems thinking: Common Ground or Untapped Territory? *55th Meeting of the International Society for the Systems Sciences*. Hull, UK.

Capra, F. (1996). *The Web of Life: A New Scientific Understanding of Living Systems.*, Doubleday, New York.
Capra, F. (2002). *Hidden Connections: A Science for Sustainable Living*., Harper Collins.
Chaturvedi, D. K. (2009). *Modeling and Simulation of Systems Using MATLAB and Simulink*., Taylor & Francis, London.
Checkland, P. (1999). *Systems Thinking, Systems Practice (30 Year Retrospective).,* Wiley, Oxford UK.
De Quincey, C. (2005). *Radical Knowing: Understanding Consciousness through Relationship.* Park Street Press.
Everatt, J., Steffert, B., & Smythe, I. (1999). An Eye for the Unusual: Creative Thinking in Dyslexics, *Dyslexia*., 5(1):28-46.
Forrester, J. (1971). Counterintuitive Behavior of Social Systems, *Technology Review*., 73(3): 52-68.
Gharajedaghi, J. (2005). *Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture* (2nd ed)., Butterworth-Heinemann, Maryland Heights MO.
Hardy, J. (1996). *A Psychology with a Soul: Psychosynthesis in Evolutionary Context*., Woodrange Press.
Hitchins, D. K. (2007). *Systems Engineering: A 21st Century Systems Methodology*., Wiley, Chichester.
INCOSE 2009. *What is Systems Engineering?* INCOSE UK 'Z-Guide' Z1. http://www.incoseonline.org.uk/Documents/zGuides/Z1_What_is_SE.pdf <accessed 20th April 2012.
Jackson, M. C. (2000). *A Systems Approach to Management*., Kluwer, New York.
Jackson, M. C. (2003). *Systems Thinking: Creative Holism for Managers*., Wiley, Chichester.
Jung, C. (1971). *Psychological Types*., Routledge & Kegan Paul, London.
Laszlo, E. (1996). *The Systems View of the World: A Holistic Vision for our Time.* Hampton Press, Inc.
Laszlo, E. (2006). *Science and the Reenchantment of the Cosmos: The Rise of the Integral Vision of Reality*., Inner Traditions, Vermont.
Midgley, G. (1997). Dealing with Coercion: Critical Systems Heuristics and Beyond, *Systems Practice*., 10, 37-57.
Midgley, G. (2000). *Systemic Intervention: Philosophy, Methodology, and Practice*., Kluwer Publishers, New York.
Mingers, J. (2003). A Classification of the Philosophical Assumptions of Management Science Methods, *Journal of the Operational Research Society*., 54(6), pp. 559-570.
Myers, I., McCaulley, M., & Most, R. (1985). *Manual, a Guide to the Development and Use of the Myers-Briggs Type Indicator***.,** Consulting Psychologists Press, Palo Alto, California.
Nonaka, I. (1994). A dynamic theory of organizational knowledge creation, Organization Science., 5:1 14-37.
Palmer, Gary B. (1996). *Toward A Theory of Cultural Linguistics*., University of Texas Press.
Pidd, M. (2004). *Systems Modelling: Theory and Practice*., Wiley, Chichester.
Pulkkinen, O. (2007). Emergence of Cooperation and Systems Intelligence, in *Systems Intelligence in Leadership*, (Hämäläinen, R. and Saarinen, E. eds.), Helsinki University of Technology Systems Analysis Laboratory, Helsinki. (pp. 251-266)

RAEng (2007). *Creating Systems that Work: Principles of Engineering Systems for the 21st Century*. (Elliott, C. and Deasley, P. eds) Royal Academy of Engineering.

Rantanen, M. (2007). Reasons of Systemic Collapse in Enron, in *Systems Intelligence in Leadership*, (Hämäläinen, R. and Saarinen, E. eds.), Helsinki University of Technology Systems Analysis Laboratory, Helsinki. (pp. 171-186)

Reed, P., Lowe, C., & Everett, R. (2011). Perceptual Learning and Perceptual Search are Altered in Male University Students with Higher Autism Quotient Scores, *Journal of Personality and Individual Differences*., 51:732-736.

Riding R., & Cheema, I. (1991). Cognitive Styles – An Overview and Integration, *Educational Psychology: An International Journal of Experimental Educational Psychology*., 11:193-215.

Senge, P. (1990). *The Fifth Discipline*., Doubleday, New York.

Seppä, L. (2007). On the Systems Intelligence of Forgiveness, in *Systems Intelligence in Leadership,* (Hämäläinen, R. and Saarinen, E. eds.), Helsinki University of Technology Systems Analysis Laboratory, Helsinki. (pp. 155-170)

Singer, J., Loomis, M., Kirkhart, E., & Kirkhart, L (1996). *The Singer-Loomis Deployment Inventory (4.2 ed.)* Moving Boundaries, Gresham OR.

Sterman, J. (2000). *Business Dynamics: Systems Thinking and Modeling for a Complex World*., Irwin McGraw-Hill, New York.

Ulrich, W 1998 *Systems Thinking as if People Mattered: Critical Systems Thinking for Citizens and Managers* (Working Paper No. 23) Lincoln: University of Lincoln

Ulrich, W. (1983). *Critical Heuristics of Social Planning*., Haupt, Bern.

Yearworth, M. (2011) The Role of the Systems Supervisor for an Engineering Doctorate in Systems. *55th Meeting of the International Society for the Systems Sciences.* Hull, UK.

Yearworth, M., Edwards, G. & Rosenberg, G. (2011) Systems Practice in Engineering: Reflections on Teaching Research Methods and Contribution to Methodological Development. *9th Annual Conference on Systems Engineering Research (CSER 2011).* Los Angeles, USA.